EMERGENCY SPILLWAY PERFORMANCE AT SITE 39, UPPER BLACK BEAR CREEK WATERSHED, OKLAHOMA

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ILLUSTRATIONS

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EMERGENCY SPILLWAY PERFORMANCE AT SITE 39, UPPER BLACK BEAR CREEK WATERSHED, OKLAHOMA

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ABSTRACT

A study was made at the floodwater-retarding reservoir at site 39, Upper Black Bear Creek watershed, Oklahoma, to evaluate the stability and performance of the emergency spillway following a 2-day storm. The results of the various measurements, calculations, and observations of the spillway area indicated that the peak mean velocity of 7.7 feet per second in the spillway during the flow event did very little damage to the spillway except for the formation of small gullies in areas which were probably deficient in grass cover before the storm.

INTRODUCTION

The emergency spillway for the floodwater-retarding reservoir at site 39, Upper Black Bear Creek watershed project, carried flow following a storm on August 9–10, 1974. According to the National Oceanic and Atmospheric Administration, rainfall during this period totaled 10.63 inches at Garber, Okla., just 5 miles north-northeast of the dam. A "bucket survey" by the Soil Conservation Service indicated that rainfall within the watershed was about 10 inches. The maximum head on the spillway crest during this event was 2.17 feet. The flow at this head was sufficient to test the stability of the emergency spillway, so staff members of the Agricultural Research Service's Water Conservation Structures Laboratory at Stillwater, Okla., visited the site on August 27 to secure detailed information on the performance of the spillway. These data are recorded in this report for use in future research on the stability of earth emergency spillways.

The floodwater-retarding dam was built under the Watershed Protection and Flood Prevention Act, Public Law 566, as part of the flood-control system for the Upper Black Bear Creek watershed. The drainage area above the dam at site 39 is 4,442 acres. Most of the watershed above the dam is used for wheat production and

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cattle grazing. Figure 1 shows a portion of the Upper Black Bear Creek watershed and the location of site 39.

The emergency spillway for the reservoir is a grassed channel around the left end of the dam (facing downstream); its dimensions are given in figure 2. The spillway was constructed by excavating to cross section and subgrade in undisturbed soil, adding topsoil to a depth of 6 inches, and planting bermudagrass. Information on the soil in the spillway subgrade was obtained from the Soil Conservation Service and includes soil class — CL (unified classification); liquid limit — 42; plasticity index — 22; soluble salt — less than 0.5 percent; dispersion index — trace; and grain size distribution — 100% < No. 10 sieve (2.0 mm), 82% < No. 200 sieve (0.074 mm), 73% < 0.05 mm, 50% < 0.02 mm, 38% < 0.005 mm, and 33% < 0.002 mm.

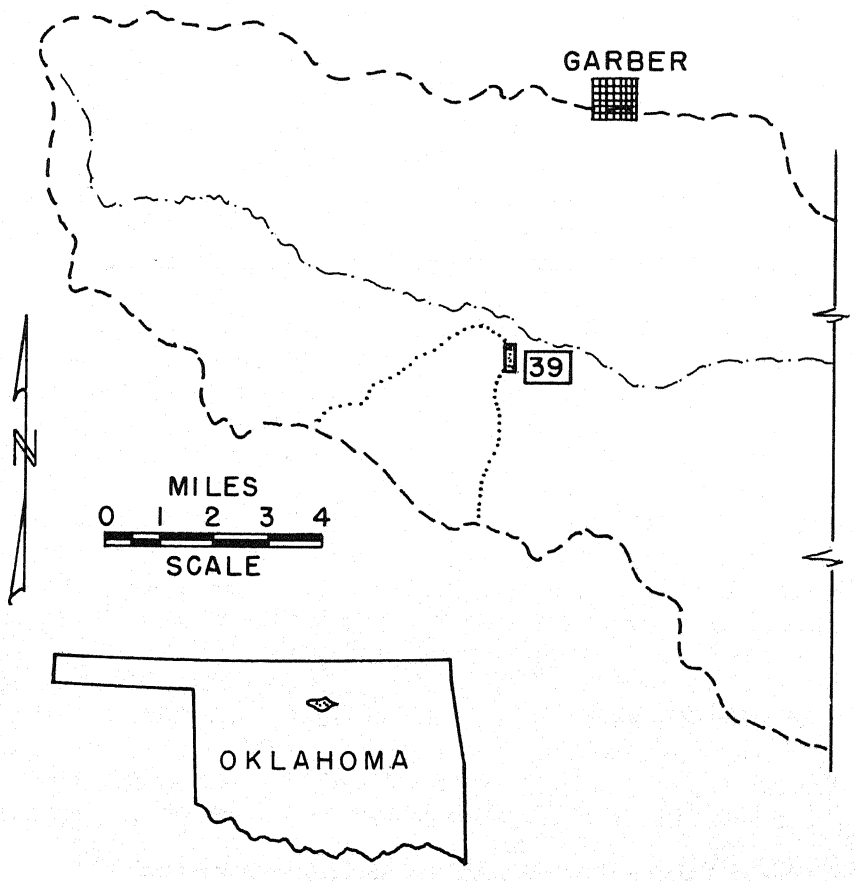

FIGURE 1.—West end of Upper Black Bear Creek watershed, showing locations of watershed and site 39 floodwater-retarding dam.

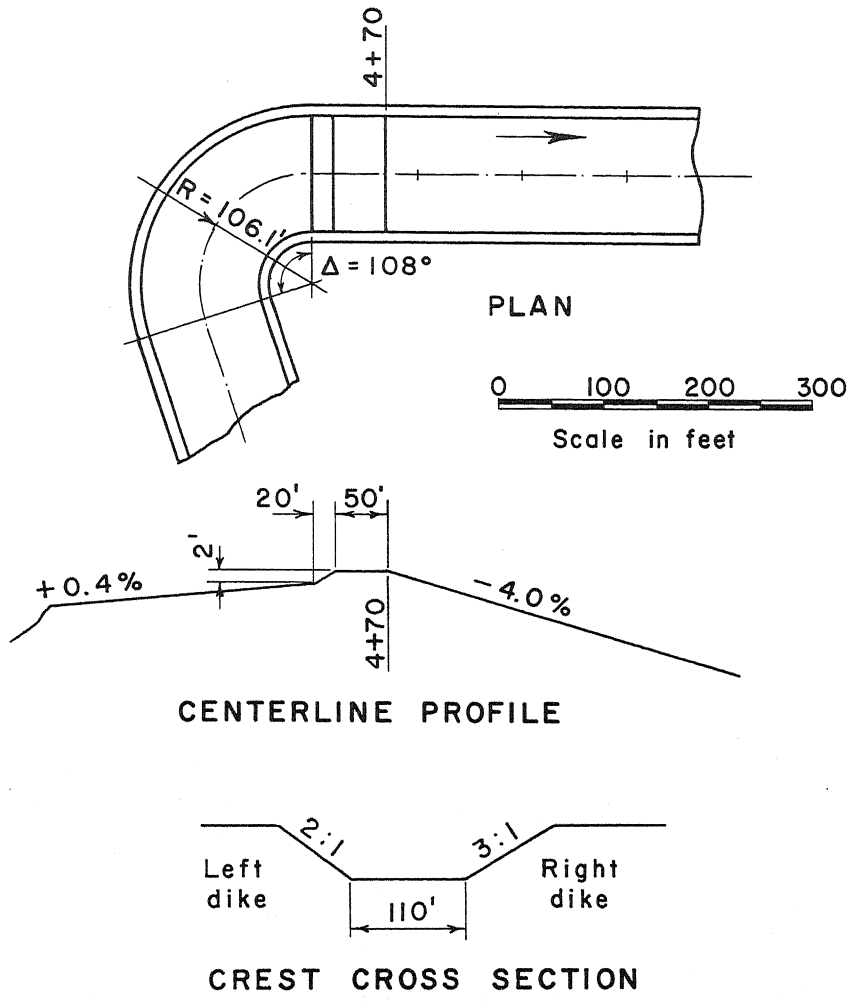

FIGURE 2.—Dimensions of emergency spillway for floodwater-retarding dam.

OBSERVATIONS AND CALCULATIONS

At the time of the inspection, more than 2 weeks after the storm, the high-water marks were still well defined. Measurements were made of the elevation of these high-water marks in the reservoir and of the centerline profile and crest cross section of the emergency spillway. Experience from similar studies indicates that accurate estimates of the flow require the use of the actual elevati- and dimensions of the spillway crest at the time of the flow. It is not satisfactory to rely on plan elevations and Also, the high-water-mark elevations must be referred used for the emergency spillway measurements.

The grass in the spillway was in fair to good condition and was about 8 inches tall (fig. 3). Coverage was complete and fairly uniform except for a strip along the left side and a strip along the lower right side (facing downstream). The retardance class for the grass was estimated as being between a C and a D.[2]

The head-discharge relationship for the spillway was estimated by calculating water-surface profiles from the downstream edge of the spillway crest (the control in this case) upstream into the reservoir.[3] Entering a plotting of the derived head-discharge relationship with a head of 2.17 feet yielded a peak-flow estimate of 720 cubic feet per second. A calculation of the water-surface profile downstream of the crest indicated that normal flow was supercritical (with a Froude number of 1.5) and was reached within 10 feet, and the mean velocity for normal flow was 7.7 feet per second.

This normal flow did very little damage to the spillway except for forming some small gullies in areas which were probably deficient in grass cover before the storm.

[2] Handbook of channel design for soil and water conservation. 1954. U.S. Dep. Agric., Soil Conserv. Serv. [Rep.] SCS–TP–61, 34 pp.

[3] Ree, W. O. 1975. Emergency spillway performance, Upper Red Rock Creek watershed, Oklahoma. U.S. Dep. Agric., Agric. Res. Serv. [Rep.] ARS–S–108.

FIGURE 3.—Bermudagrass cover on crest of emergency spillway.

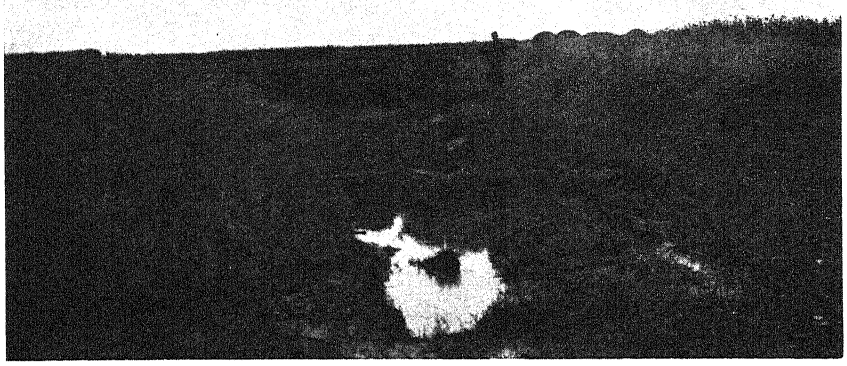

FIGURE 4.—Gully about 100 feet long by 7 feet wide by 2 feet deep along left side of emergency spillway.

Erosion along the left side had formed a gully about 100 feet long by 7 feet wide by 2 feet deep (fig. 4). Upstream of this gully, a barren strip with some sheet erosion extended up to and over the spillway crest. There was no vegetation along the left side of the crest for a width of about 6 feet. Just outside the spillway and on the left bank at the crest was a capped, abandoned oil well. The area around the well also lacked vegetation, probably the result of effluent from the well (fig. 5).

FIGURE 5.—Capped, abandoned oil well (to left) alongside crest of emergency spillway and barren strip (to right) on spillway crest.

FIGURE 6.—Healed, small gully to right of lower end of emergency spillway.

A healed gully with minor erosion was observed along the right side of the lower part of the spillway (fig. 6). The old gully probably formed before a complete grass cover had been established. There is a possibility that this portion of the emergency spillway bottom was in a filled area. The "as built" plans for this structure showed that, in this vicinity, the spillway grade was actually built higher than was called for in the original plans. However, it is not known for certain that this was a filled area.

The peak mean velocity of 7.7 feet per second in the spillway during the flow event is less than the permissible velocity of 8 feet per second for this site when the vegetation is in uniformly good condition, so no damage should have occurred to the spillway.[4] Damage to the spillway was minor and occurred only in previously weakened areas.

[4] Permissible velocity calculated according to Soil Conservation Service criteria. See footnote 2.

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